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THE PERFECTED PHONOGRAPH.

TEN years ago I contributed to the NORTH AMERICAN REVIEW (May-June, 1878), a paper on the "Phonograph and its Future," in which I sketched the solution of certain problems accomplished by my invention, and predicted some of the uses to which it would be put. Other weighty matters engaged much of my time and attention after that article was published, but the future of which I then spoke has now arrived, and the predictions which I made at that time are now verified. For, when these words appear in print, the demonstration of the phonograph's practical adaptability to the purposes mentioned by me will have been completed, and the perfected instrument itself will be in the hands of the public, to be tested and employed by them at will. Rumors, I understand, have been circulated to the effect that, subsequently to my announcements made ten years ago, I allowed the phonograph to go adrift, leaving its further development to chance and to the tender mercies of such disinterested persons, not connected with me, as might conceive that they were doing me a favor by claiming to have developed my idea. Those who may have been taken in by these rumors would do well to inform themselves concerning the prolonged labor involved in carrying out important inventions. They are also referred to my former statements in this REVIEW, as proof that the signer of those statements at least knew clearly what he was talking about and predicted only that which he has now fulfilled.

Since the time of Lucretius, the movements of atoms have been invested with an intense interest for philosophers and scientific students, and the wave-motions of light, heat and sound have engaged, with a constantly increasing degree of importance, the attention of modern investigators. When we consider the relation of these motions to mathematics and to music, the conception of Pythagoras that number and harmony constituted the

principle of the Universe does not seem to be very far out of the way. In the phonograph we find an illustration of the truth that human speech is governed by the laws of number, harmony and rhythm. And by means of these laws, we are now able to register all sorts of sound and all articulate utterance—even to the lightest shades and variations of the voice—in lines or dots which are an absolute equivalent for the emission of sound by the lips; so that, through this contrivance, we can cause these lines and dots to give forth again the sound of the voice, of music, and all other sounds recorded by them, whether audible or *inaudible*. For it is a very extraordinary fact that, while the deepest tone that our ears are capable of recognizing is one containing 16 vibrations a second, the phonograph will record 10 vibrations or less, and can then raise the pitch until we hear a reproduction from them. Similarly, vibrations above the highest rate audible to the ear can be recorded on the phonograph and then reproduced by lowering the pitch, until we actually hear the record of those inaudible pulsations.

To make the general idea of the recording of sound more clear, let me remark one or two points. We have all been struck by the precision with which even the faintest sea-waves impress upon the surface of a beach the fine, sinuous line which is formed by the rippling edge of their advance. Almost as familiar is the fact that grains of sand sprinkled on a smooth surface of glass or wood, on or near a piano, sift themselves into various lines and curves according to the vibrations of the melody played on the piano-keys. These things indicate how easily the particles of solid matter may receive an imparted motion, or take an impression, from delicate liquid waves, air waves, or waves of sound. Yet, well known though these phenomena are, they apparently never suggested until within a few years that the sound-waves set going by a human voice might be so directed as to trace an impression upon some solid substance, with a nicety equal to that of the tide in recording its flow upon a sand beach.

My own discovery that this could be done came to me almost accidentally while I was busy with experiments having a different object in view. I was engaged upon a machine intended to repeat Morse characters, which were recorded on paper by indentations that transferred their message to another circuit automatically, when passed under a tracing-point connected with a circuit-clos-

ing apparatus. In manipulating this machine I found that when the cylinder carrying the indented paper was turned with great swiftness, it gave off a humming noise from the indentations—a musical, rhythmic sound resembling that of human talk heard indistinctly. This led me to try fitting a diaphragm to the machine, which would receive the vibrations or sound-waves made by my voice when I talked to it, and register these vibrations upon an impressible material placed on the cylinder. The material selected for immediate use was paraffined paper, and the results obtained were excellent. The indentations on the cylinder, when rapidly revolved, caused a repetition of the original vibrations to reach the ear through a recorder, just as if the machine itself were speaking. I saw at once that the problem of registering human speech, so that it could be repeated by mechanical means as often as might be desired, was solved.

The history of the phonograph as it was then devised and manufactured in small quantity, merely for purposes of public exhibition and explanation, need not be repeated here. The idea occurred to me in the spring of 1877, and, according as I could get leisure, I gave my attention to preparing the few exhibition machines which were placed before the public in 1878, and then universally recognized by scientific men and every one else as an absolute novelty. These machines, of course, exemplified only a small part of the capacity of the phonograph. I was hard at work describing and noting down the various parts of the machine as it would appear when perfected, and making drawings of them in various forms.

As it was impossible to drop my work and sit down to tell the public what I was doing every day, I noted briefly in my *NORTH AMERICAN REVIEW* article of May-June, 1878, some of the things which I proposed to accomplish. The details of the electric light and other inventions afterwards absorbed much of my time and attention. My laboratory was converted into a factory in order to supply the demand for the electric light, and my progress in carrying out my ideas about the phonograph, though continuous, was necessarily retarded. For months past, however, I have had a special factory in operation, producing the component parts of the perfected phonograph, so as to bring the machine within the reach of the public in the form which I originally designed it to take.

It may be of interest, here, to contrast briefly the perfected phonograph with the mere exhibition models shown, all over the world, in 1878. Those models were large, heavy machines which purposely sacrificed distinctness of articulation, in order to secure a loud tone which could be heard in a large room when emitted through a funnel-shaped transmitter. Tin-foil was used as the material on which the indentations were to be made. The cylinders were revolved by hand, or by clock-work; and there were numerous other details of construction which differed from those of the instrument as now completed. At that time I had made various designs for a special kind of electric motor, differing from all others, to run the machine, in place of clock-work; and the phonograph as we now manufacture it is provided with such a motor, which turns the cylinder noiselessly, uniformly and easily. Instead of tin-foil, I now use a cylinder of wax for receiving the record of sound-pulsations, as in the original experiment. One diaphragm (the "recorder") receives these pulsations, which are incised on the wax, in exceedingly fine lines, hardly visible to the naked eye, by means of a small point pressing against the wax. A turning tool attachment, near this recording diaphragm pares off the surface of the wax, removing any record which may previously have been left there, and smoothing the way for whatever you wish to speak into the "recorder." When you have finished speaking, two simple motions bring the reproducing diaphragm into place directly over the wax; and this diaphragm, provided with a very delicate but durable needle, takes up and reproduces the vibrations registered in the fine lines of indentation, bringing them to the ear by means of a tube. Sometimes, indeed, one can hear the recorded words as they are thrown off by the needle from the revolving cylinder, without using a tube at all, and simply by putting the ear close to the wax. The adjustments of these receiving and transmitting diaphragms, known as the "recorder" and the "reproducer," are very exact, but very easily arranged. And a machine, once adjusted after being set up, will run well with very little attention or readjustment, for a long period of time. The battery, also, conveniently placed in a box under the desk which holds the instrument, will last for six weeks or more, according to use, without renewal. A scale and indicator running the whole length of the cylinder, in front, enable you to observe at what point you began talking, so that the reproducer

may be set at that point on the wax as soon as you wish to take off the record. Another very handy attachment supplies a key for suspending the reproduction of sounds when it is going on too rapidly for the copyist who is writing it out. A second key, when pressed down, will run the reproducer back so as to repeat anything which has not been clearly understood, and this may be done any desired number of times.

A single wax cylinder, or blank, may be used for fifteen or twenty successive records before it is worn out. But if the record is to be kept, the wax blank must not be talked upon again, and is simply slipped off from the metal cylinder and filed away for future reference. It may be fitted on to the cylinder again at any time, and will at once utter whatever has been registered on it. One of these wax blanks will repeat its contents thousands of times with undiminished clearness. Further, we are able to multiply to any extent, at slight cost, phonographic copies of the blank, after the talking, or music, or other sounds have been put upon it once.

It is curious to reflect that the Assyrians and Babylonians, 2,500 years ago, chose baked clay cylinders inscribed with cuneiform characters, as their medium for perpetuating records; while this recent result of modern science, the phonograph, uses cylinders of wax for a similar purpose, but with the great and progressive difference that our wax cylinders speak for themselves, and will not have to wait dumbly for centuries to be deciphered, like the famous Kileh-Shergat cylinder, by a Rawlinson or a Layard. With our facilities, a sovereign, a statesman, or a historian, can inscribe his words on a phonograph blank, which will then be multiplied a thousand-fold; each multiple copy will repeat the sounds of his voice thousands of times; and so, by reserving the copies and using them in relays, his utterance can be transmitted to posterity, centuries afterwards, as freshly and forcibly as if those later generations heard his living accents. Instrumental and vocal music—solos, duets, quartets, quintets, etc.—can be recorded on the perfected phonograph with startling completeness and precision. How interesting it will be to future generations to learn from the phonograph exactly how Rubinstein played a composition on the piano; and what a priceless possession it would have been to us, could we have Gen. Grant's memorable words, "Let us have peace," inscribed on the phonograph for perpetual reproduction in

his own intonations ! We are in a position to obtain results of this sort, by the present phonograph, from the wave-motions of sound ; so that it seems to me we realize here the “ poetry of motion ” in a new sense, combined with the *science* of motion.

In my article ten years ago, I enumerated among the uses to which the phonograph would be applied : 1. Letter writing and all kinds of dictation without the aid of a stenographer. 2. Phonographic books, which would speak to blind people without effort on their part. 3. The teaching of elocution. 4. Reproduction of music. 5. The “ Family Record ”—a registry of sayings, reminiscences, etc., by members of a family, in their own voices, and of the last words of dying persons. 6. Music boxes and toys. 7. Clocks that should announce in articulate speech the time for going home, going to meals, etc. 8. The preservation of languages, by exact reproduction of the manner of pronouncing. 9. Educational purposes ; such as preserving the explanations made by a teacher, so that the pupil can refer to them at any moment, and spelling or other lessons placed upon the phonograph for convenience in committing to memory. 10. Connection with the telephone, so as to make that invention an auxiliary in the transmission of permanent and invaluable records, instead of being the recipient of momentary and fleeting communications.

Every one of these uses the perfected phonograph is now ready to carry out. I may add that, through the facility with which it stores up and reproduces music of all sorts, or whistling and recitations, it can be employed to furnish constant amusement to invalids, or to social assemblies, at receptions, dinners, etc. Any one sitting in his room alone may order an assorted supply of wax cylinders inscribed with songs, poems, piano or violin music, short stories, anecdotes, or dialect pieces, and, by putting them on his phonograph, he can listen to them as originally sung or recited by authors, vocalists and actors, or elocutionists. The variety of entertainment he thus commands, at trifling expense and without moving from his chair, is practically unlimited. Music by a band, in fact whole operas, can be stored up on the cylinders, and the voice of Patti singing in England can thus be heard again on this side the ocean, or preserved for future generations. On four cylinders eight inches long, with a diameter of five, I can put the whole of “ Nicholas Nickleby ” in phonogram

form. In teaching the correct pronunciation of English, and especially of foreign languages, the phonograph as it stands seems to be beyond comparison, for no system of phonetic spelling can convey to the pupil the pronunciation of a good English, French, German or Spanish speaker so well as a machine that reproduces his utterance even more exactly than a human imitator could.

The speeches of orators, the discourses of clergymen, can be had "on tap," in every house that owns a phonograph. It would not be very surprising if, a few years hence, phonographic newspaper bulletins should be issued on wax cylinders. Even now, so soon as the phonograph comes into general use, newspaper reporters and correspondents can talk their matter into the phonograph, either in the editorial office or at some distant point, by a telephone wire connected with a phonograph in the composing-room, so that the communication may be set up in type without any preliminary of writing it out in long hand.

The wax cylinders can be sent through the mails in little boxes which I have had prepared for that purpose, and then put upon another phonograph at a distant point, to be listened to by a friend or business correspondent. To obviate the difficulty caused by the friend's not having a phonograph of his own, pay stations will be established, to which any one may take the phonogram that he has received, have it placed on the instrument, and the contents recited to him from the machine, as well as copied out at the same moment by a type-writer. Thus the phonograph will be at the service of every one who can command a few cents for the fee. And which of us would not rather pay something extra, in order to hear a dear friend's or relative's voice speaking to us from the other side of the earth?

Authors can register their fleeting ideas and brief notes on the phonograph at any hour of day or night, without waiting to find pen, ink or paper, and in much less time than it would take to write out even the shortest memoranda. They can also publish their novels or essays exclusively in phonogram form, so as to talk to their readers personally; and in this way they can protect their works from being stolen by means of defective copyright laws. Musical composers, in improvising compositions, will be able to have them recorded instantaneously on the phonograph.

For the present it has been decided to make all the phonographs of uniform size; so that a record put upon the machine

in New York may be placed on another machine of the same pattern in China, and speak exactly as it was spoken to on this continent. Each wax blank will receive from 800 to 1,000 words; and of course several blanks may be used for one document, if needed. This uniform size and pattern make the thing perfectly practicable in offices which have business connections all over the globe. My private secretary to-day speaks all letters into a phonograph, from which they are taken off by a type-writer or ordinary long-hand writer, with an immense saving of time and trouble. Persons having a large correspondence can talk all their letters into the phonograph in a very short time, and leave them to be listened to and copied by an assistant, without the delay involved in stenography or the trouble of going over and correcting the copyist's work, which is almost inevitable under the conditions of dictation now prevailing.

Furthermore, two business men, conferring together, can talk into the recorder by means of a double transmitting tube, with perfect privacy, and yet obtain upon the cylinder an unimpeachable transcript of their conversation in their own voices, with every break and pause, every hesitation or confident affirmation, every partial suggestion or particular explanation, infallibly set down in the wax.

They can then have this conversation written out or typed by a secretary, for future reference; or can, if they prefer, have it multiple-copied by our mechanical process. In this way, many misunderstandings may be avoided. Interesting philosophic or literary discussions and dialogues may be recorded in the same way. In fact, the phonograph will do, and does at this moment accomplish, the same thing in respect of conversation which instantaneous photography does for moving objects; that is, it will present whatever it records with a minute accuracy unattained by any other means.

The most skillful observers, listeners and realistic novelists, or even stenographers, cannot reproduce a conversation exactly as it occurred. The account they give is more or less generalized. But the phonograph receives, and then transmits to our ears again, every least thing that was said—exactly *as* it was said—with the faultless fidelity of an instantaneous photograph. We shall now for the first time know what conversation really is; just as we have learned, only within a few years, through the

instantaneous photograph, what attitudes are taken by the horse in motion.

Letters of introduction may be spoken on to a phonograph blank, without any of the formality of address and phraseology now customary, or the trouble of folding, enveloping and addressing a written communication. In fact all correspondence will be greatly simplified and wisely abbreviated by the use of phonograms. A telephone subscriber can place at his telephone a phonogram which will announce to the exchange, whenever he is called up, that he has left the office and will return at a certain time. Similarly, one man calling at the office of another and not finding him, will talk into the phonograph anything he wishes to say. This saves the trouble of writing a note, and obviates the uncertainty of giving to clerk, office boy or servant an oral message that may be forgotten or incorrectly delivered. Hotels and clubs will, naturally, find this function of the phonograph extremely serviceable; and their guests, or patrons, will avail themselves of phonograms constantly. The accuracy of interviews with newspaper reporters will also be determined, no doubt, by phonographic record. And travelers in vestibule trains will be glad to use phonograph blanks in place of letter paper and telegraph blanks, owing to the difficulty of writing while on a rapidly moving train.

It must be borne in mind that I am not talking now of things which may be made possible in the future. I did my predicting ten years ago; and the functions above mentioned are those which the present perfected phonograph is able to fulfill at this moment. To use the phonograph, a little instruction and practice are needed, but much less than the type-writer requires and hardly more than the training needed for the operation of a sewing-machine.

Various other uses for which the phonograph is now fully ripe might be mentioned; but I do not want to give to these memoranda the character of a catalogue. Enough has been said, I think, to indicate that the phonograph, unlike children, should be "seen" and "heard." It is no longer in a state of infancy. It may be still in its childhood; but it is destined to a vigorous maturity. The phonograph, in one sense, knows more than we do ourselves. For it will retain a perfect mechanical memory of many things which we may forget, even though we have said

them. It will become an important factor in education; and it will teach us to be careful what we say—for it imparts to us the gift of hearing ourselves as others hear us—exerting thus a decidedly moral influence by making men brief, businesslike and straightforward, cultivating improved manners, and uniting distant friends and associates by direct vocal communication.

THOMAS A. EDISON.